



Uninterruptible Power Supply (UPS) & Battery Energy Storage System (BESS)



Data Center



Industrial



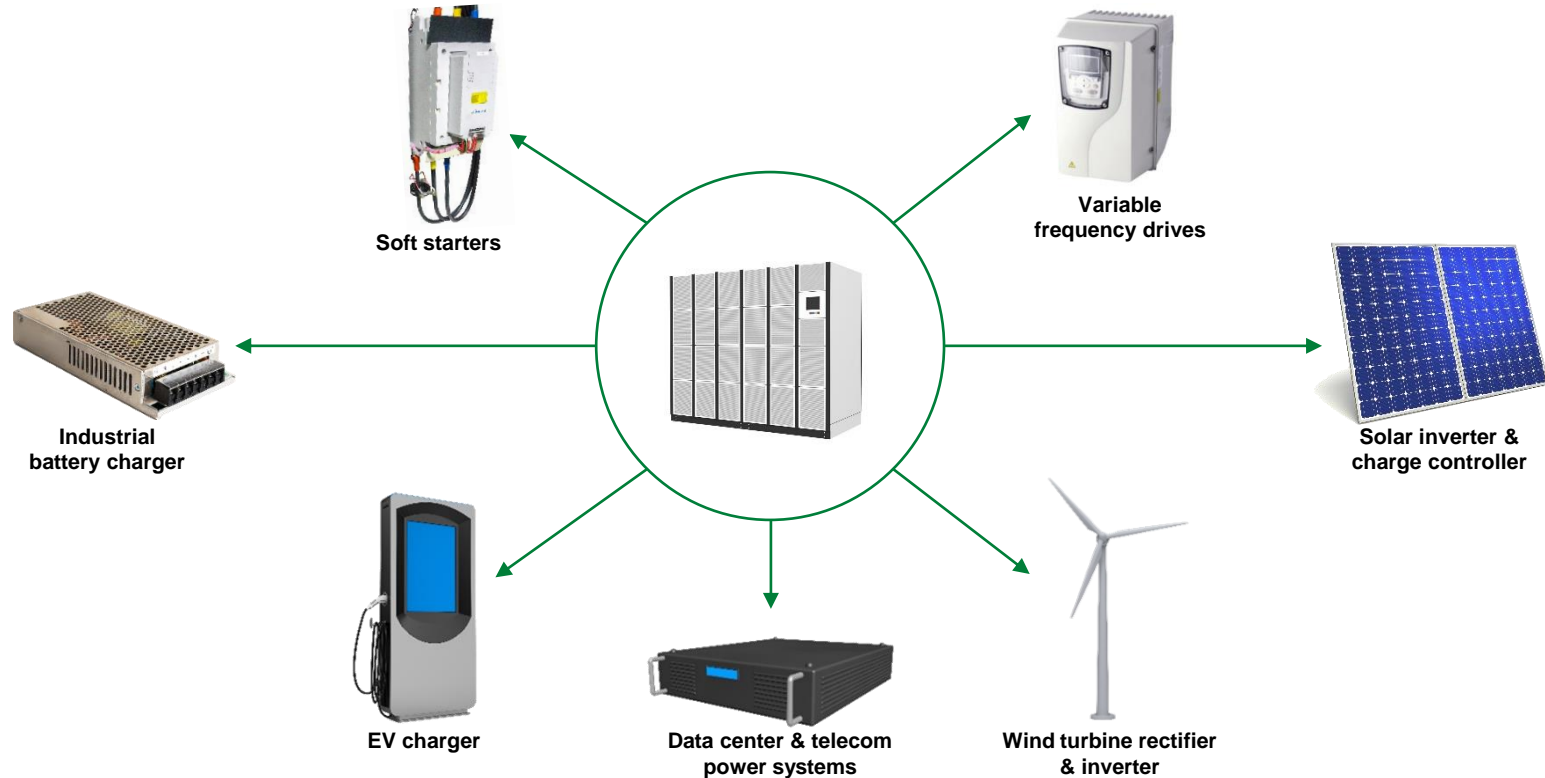
Renewable Energy



Littelfuse®

Expertise Applied | Answers Delivered

UPS shares similar architecture with multiple industrial and renewable energy systems



Energy efficiency and reliability continue to drive UPS market sales

Market trends and drivers

Global UPS market estimated to grow at 5% CAGR for next 5 years

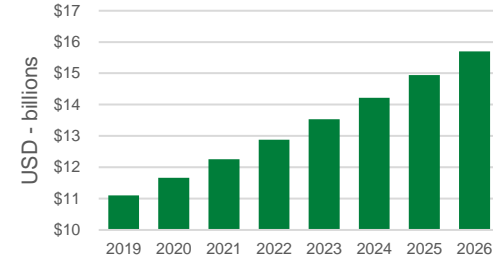
Need for reliable electrical energy is driving increased sales to data centers, medical, industrial, and consumer markets

Increasing energy-efficiency requirements are causing data centers to prefer multi-mode, line-interactive UPS

Power surges and failures are key growth drivers for UPS in Europe

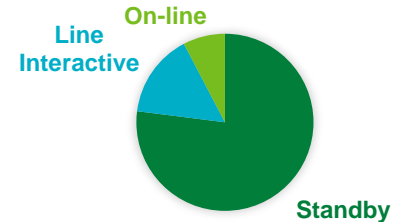
Lithium-ion batteries are the preferred energy storage system for UPS due to high energy density and long shelf life

Global UPS market sales



Source: [Global UPS Market](#) (360ResearchReports, 2020), marking estimates

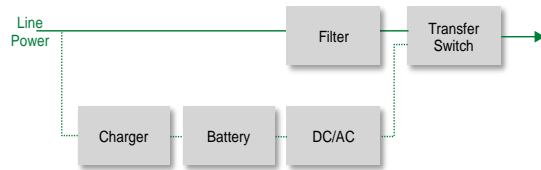
Data center UPS by type



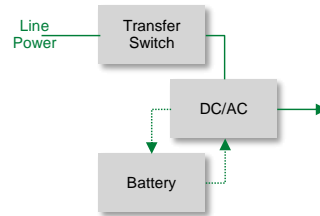
Source: [Data center UPS market](#) (Global Market Insights, 2019), marking estimates

Ideal UPS type depends on system priority of key characteristics

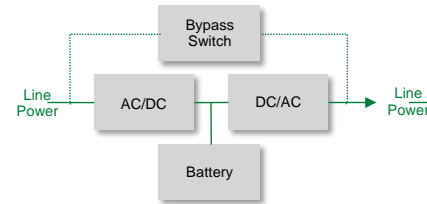
Standby



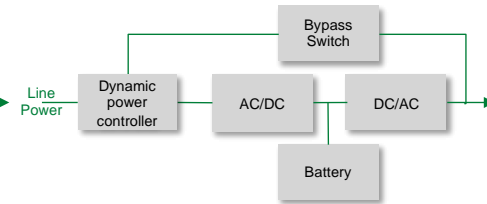
Line interactive



Double conversion on-line



Multi-mode



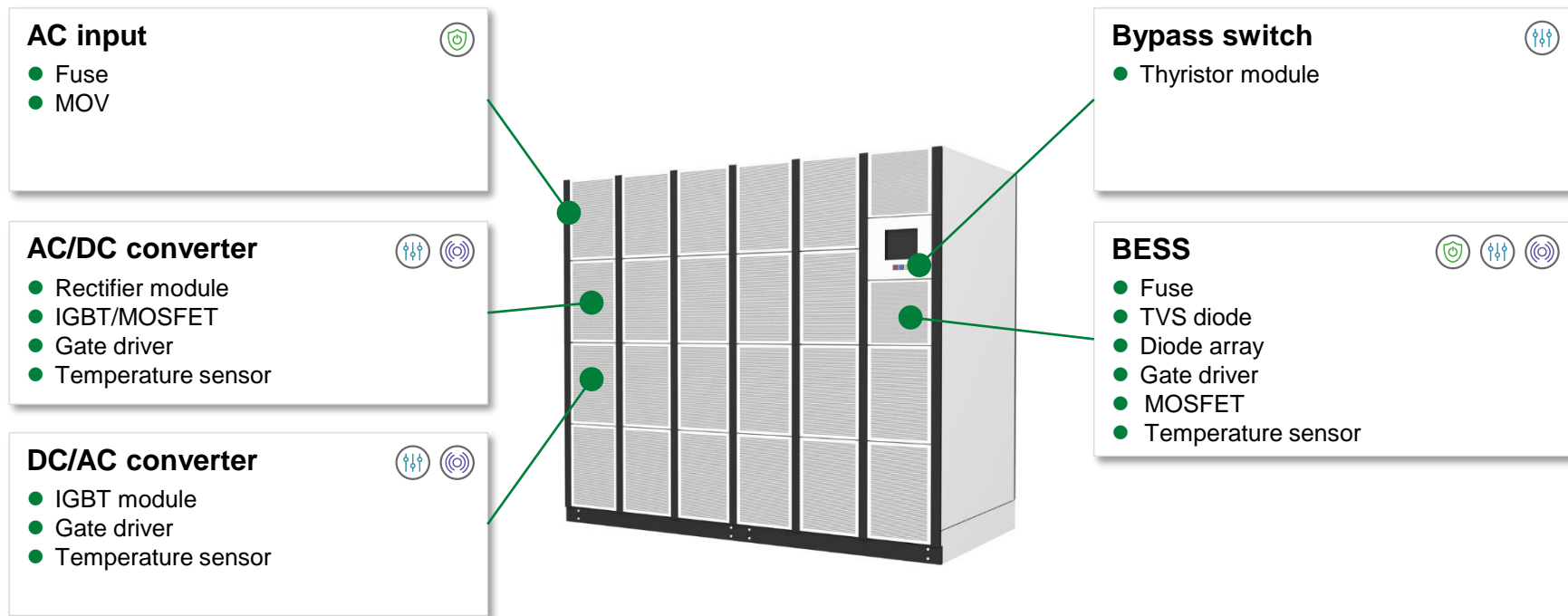
Energy efficiency	Very high
Switching time	High – Switching from line power to battery takes a few electrical cycles
Filtering	Medium
Cost per VA	Low
Typical UPS size	< 0.5 kVA

Energy efficiency	Very high
Switching time	Low
Filtering	High
Cost per VA	Medium
Typical UPS size	0.5 to 5 kVA

Energy efficiency	Medium – Power conversion causes some loss
Switching time	Zero – Power always flows through inverter
Filtering	Very high
Cost per VA	Medium
Typical UPS size	> 5 kVA

Energy efficiency	Medium – Power conversion causes some loss
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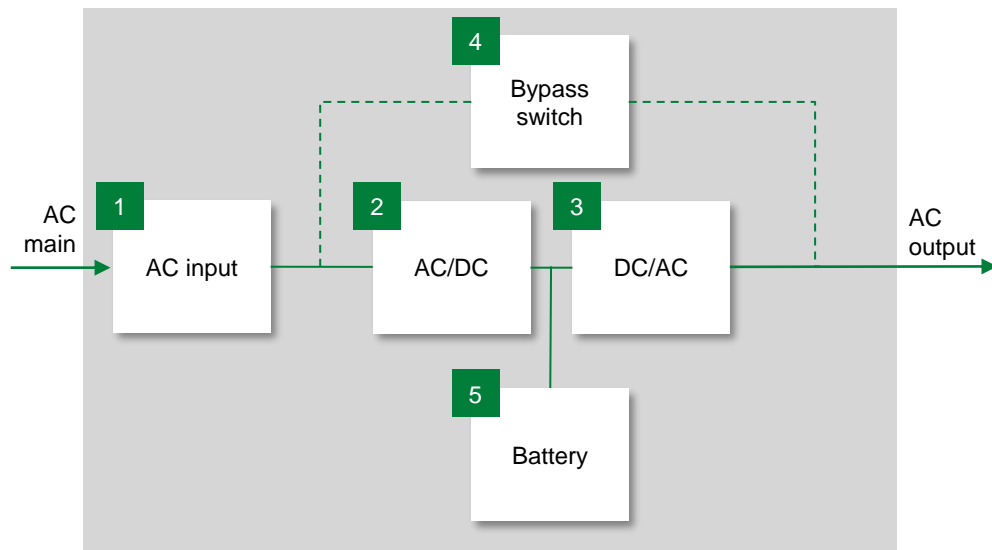
Littelfuse solutions for UPS





Click on the product series in the table below for more info

UPS Block Diagram



Notes:

- I. Double conversion on-line UPS diagram used as representative model. Other topologies will have similar solution needs at common power levels.
- II. Many other fuse options available based on system attributes such as current, voltage, available fault current, surge withstand, and sensitivity of semiconductors.
- III. For faster response, consider P6KE or a combination of a SIDACTor® and an MOV (P3500SCLRP + LA series).
- IV. Rectifier diodes can potentially be substituted with active rectification through IGBT for improved functionality.
- V. Gate drivers may require an isolator. Contact factory for recommendations.

	Technology	Product series
1	Fuse ^{II}	PSR , JLLS , 505 , 607
	MOV ^{III}	TMOV
2	Rectifier module ^{IV}	MDD , VUO , MDMA
	IGBT and MOSFET	XPT and Ultra junction X-Class
	Gate driver ^V	IXD_6xx
	Temperature sensor	USP10976
3	IGBT module	MIXA , MIXG
	Gate driver ^V	IXD_6xx
	Temperature sensor	USP10976
4	Thyristor module	MCC , MCMA
5	See BESS block diagram (link to page)	

Acronyms:

UPS: uninterruptible power supply
MOV: metal oxide varistor

TVS: transient voltage suppressor
SMD: surface mount device



Click on the product series in the table below for more info

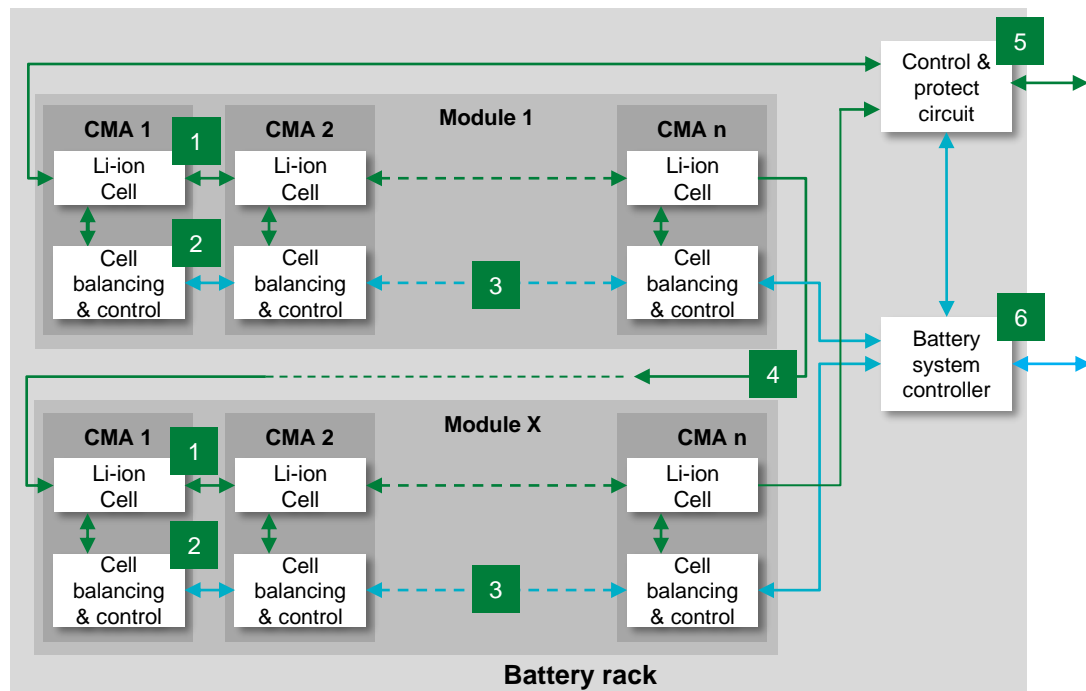
Features and benefits of Littelfuse solutions for UPS

	Technology	Function in application	Product series	Benefits	Features
1	Fuse	Overcurrent fault protection	PSR , JLLS , 505 , 607	Fast opening to protect the power conversion semiconductor components	Compact design; 200 kA interrupting rating; available with PCB mounts
	MOV	Surge voltage protection	TMOV	Promotes robust operation	Thermally protected; high peak surge current rating up to 10 kA; wave solderable
2	Rectifier module	Rectify AC to DC	MDD , VUQ , MDMA	High efficiency system operation with low heat generation	Improved temperature and power cycling; very low forward voltage drop; very low leakage current
	IGBT and MOSFET	Power factor correction	XPT and Ultra junction X-Class	Low power consumption; high efficiency system operation	Ultra low on-resistance $R_{DS(ON)}$ and gate charge Q_g ; fast body diode dv/dt ruggedness
	Gate driver	Controls the IGBT/MOSFET	IXD_6xx	Dual outputs provide space-efficient design; high immunity to latch-up; rise/fall times less than 10 ns	Tight tolerance; small form factor; fast thermal response
	Temperature sensor	Monitoring rectifier for optimal performance	USP10976	Enables robust system operation	Tight tolerance; wide range of temperature sensing
3	IGBT module	Invert DC to AC	MIXA , MIXG	Low power loss; high efficiency operation	Very low gate charge; low EMI, fast and soft reverse recovery - low operating forward voltage
	Gate driver	Controls the IGBT inverter	IXD_6xx	Dual outputs provide space efficient design; high immunity to latch-up; rise/fall times less than 10 ns	Tight tolerance; small form factor; fast thermal response
	Temperature sensor	Monitoring inverter for optimal performance	USP10976	Enables robust system operation	Tight tolerance; wide range of temperature sensing
4	Thyristor module	Switching power source	MCC , MCMA	Space saving; low thermal loss; high efficiency operation	Low forward voltage drop; leads suitable for PCB soldering; improved temperature and power cycling
5	See BESS block diagram (link to page)				



Click on the product series in the table below for more info

BESS array block diagram



	Technology	Product Series
1	Fuse	501A , 881
	Temperature sensor	USP16673 , RB
2	SMD or In-line fuse	438A , 441A , 521
	TVS diode	TPSMB , SZ1SMB , SZP6SMB
3	Diode array	AQ05C
	TVS diode	TPSMA6L , SZ1SMA
4	Fuse	TLS , JLLN , CNN
5	High-speed fuse	PSR , PSX
	MOSFET	X3 Class
	Gate driver	IXD_6xxSI
	HVDC contractor relays	DCNxx
	Arc flash relays***	AF0100
6	DC Disconnect Switch	LS6xx
	Diode array	AQ24CAN
	Fuse	885
	TVS diode	TPSMB , TPSMC



Click on the product series in the table below for more info

Potential Littelfuse products for BESS

	Technology	Function in application	Series	Benefits	Features
1	Fuse	Protects cells/BMS components from high-fault currents due to external shorts	501A , 881	Excellent temperature stability and performance reliability; compact design	Fast response to fault current; surface mount device
	TVS diode	Transient voltage suppression	TPSMC , SZ1SMC , SZ1.5SMC	Excellent clamping capability; fast response time	Meets IEC standards for ESD protection
	Temperature sensor	Monitoring the system for optimal charging conditions	USP16673 , RB	Promotes robust operation; allows design flexibility	Tight tolerance; ultra-thin
2	SMD or In-line fuse	Front end protection due to shorting of power and sense line	438A , 441A , 521	Excellent temperature stability and performance reliability; compact design	Fast response to fault current; surface mount device
	TVS diode	Protects from transients induced due to assembly and maintenance of batteries	TPSMB , SZ1SMB , SZP6SMB	Excellent clamping capability; fast response time	Meets IEC standards for ESD protection
3	Diode array	Transient voltage suppression	AQ05C	Excellent clamping capability; fast response time	Meets IEC standards for ESD protection
	TVS diode	Protects sensitive electronic ICs from ESD, EFT, and voltage transient	TPSMA6L , SZ1SMA	Ensures reliability of the equipment without performance degradation	Meets IEC standards for ESD protection; low leakage current and clamping voltage
4	Fuse	Protects from short-circuits and overloads between two packs	TLS , JLLN , CNN	Reduces damage to equipment caused by short circuit currents; compact design	Extremely current-limiting; small footprint; 200 kA interrupting rating



Click on the product series in the table below for more info

Potential Littelfuse products for BESS

	Technology	Function in application	Series	Benefits	Features
5	High-speed fuse	Short-circuit and overload protection resulting due to high-power system	PSR, PSX	Lower I^2t performance allows for quick response to protect devices from higher heat energy	High DC voltage rating up to 1500 VDC; extremely fast-acting; compact form-factor
	MOSFET	Output power control switch	X3 Class	Low power loss; design flexibility; high efficiency	Low $R_{DS(ON)}$; fast soft recovery body
	Gate driver	Controls the switching MOSFETs	IXD_6xxSI	Dual outputs provide space-efficient design; high immunity to latch-up; rise/fall times less than 10 ns	Tight tolerance; small form factor; fast thermal response
	HVDC contractor relays	The main contactors connect and disconnect the battery system	DCNxx	Allows a low voltage signal to switch the contacts for a high voltage signal	Wide range of capabilities – can switch from 10's of amps to 1000's of amps, and 10's of volts to 1000's of volts
	Arc flash relays	Reduces damage by detecting the light from an arc flash and rapidly tripping	AF0100	Fits into a wide range of arc-flash applications; monitor two arc-flash sensors; compact design	Input voltage: 100-240 VAC/VDC, 24-48 VDC, dual sensor input; surface mounting DIN RAIL
	DC Disconnect Switch	Help quickly break or resume the flow of current safely to prevent shock hazards when trying to isolate circuits or repair systems	LS6xx	energy-efficient, compact size; decreases installation and maintenance time; increase product reliability and longevity	High-level disconnection insulation; self-cleaning blade contacts; meets UL 98B, UL 94, and IEC 60947-3 standards
6	Diode array	Protects from ESD, EFT, and voltage transient	AQ24CAN	Ensures reliability of the equipment without performance degradation	Meets IEC standards for ESD protection; low leakage current and clamping voltage
	Fuse	Protects cells and BMS components from overcurrent	885	Compact design; ensures compatibility with high-temperature environment	Fast response to fault current; surface mount device
	TVS diode	Transient voltage suppression	TPSMB, TPSMC	Excellent clamping capability; fast response time	Meets IEC standards for ESD protection

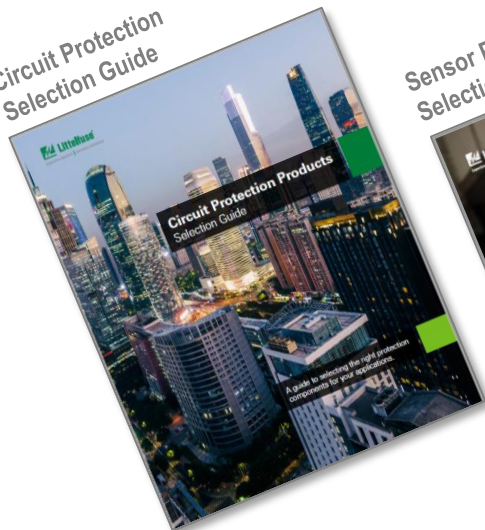
Select standards for UPS system and BESS

Standard	Title	General scope	Region
IEC 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements	This part of IEC 60204 applies to electrical, electronic and programmable electronic equipment and systems to machines not portable by hand while working, including a group of machines working together in a coordinated manner	Global
IEC 62061	Safety of machinery: Functional safety of electrical, electronic and programmable electronic control systems	Provides requirements that are applicable to the system level design of all types of machinery safety-related electrical control systems and also for the design of non-complex subsystems or devices	Global
UL 508	Standard for Industrial Control Equipment	These requirements cover industrial control devices, and devices accessory thereto, for starting, stopping, regulating, controlling, or protecting electric motors as well as industrial control devices or systems that store or process information and are provided with an output motor control function(s)	North America
UL 1778	Uninterruptible Power Systems	These requirements cover uninterruptible power supplies (UPS) rated 600 volts or less ac or dc that are intended for installation in accordance with the National Electrical Code, NFPA 70	North America
IEC 62040	Uninterruptible power systems (UPS) - Part 1: Safety requirements	This standard applies to movable, stationary, fixed or built-in UPS for use in low-voltage distribution systems, that deliver fixed frequency AC output voltage with port voltages not exceeding 1000 V AC or 1500 V DC and that include an energy storage device	Global
UL 9540A	Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems	This document evaluates the fire characteristics of a battery energy storage system that undergoes thermal runaway	North America

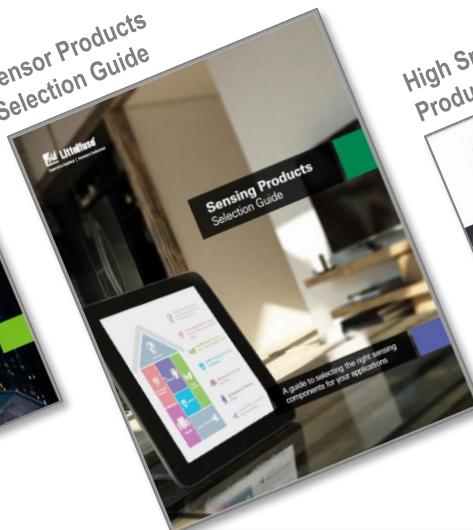
Additional information can be found on Littelfuse.com

Explore the world of Littelfuse with the electronics eCatalogs (<http://electronicscatalogs.littelfuse.com/>)

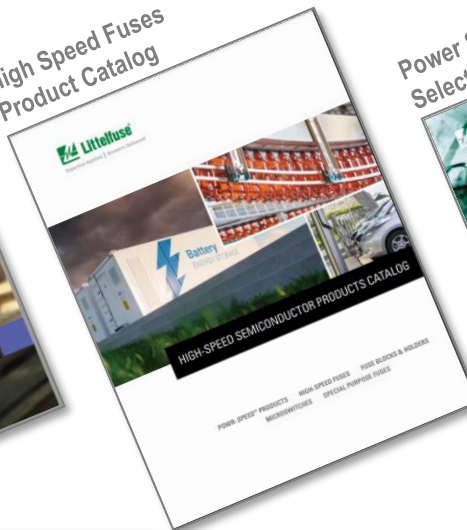
Circuit Protection Selection Guide



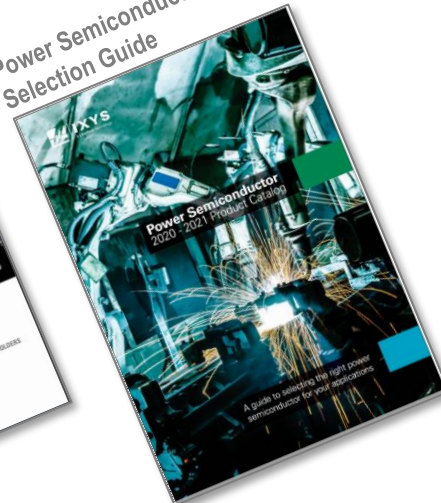
Sensor Products Selection Guide



High Speed Fuses Product Catalog

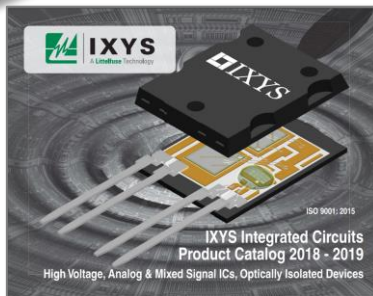


Power Semiconductor Selection Guide



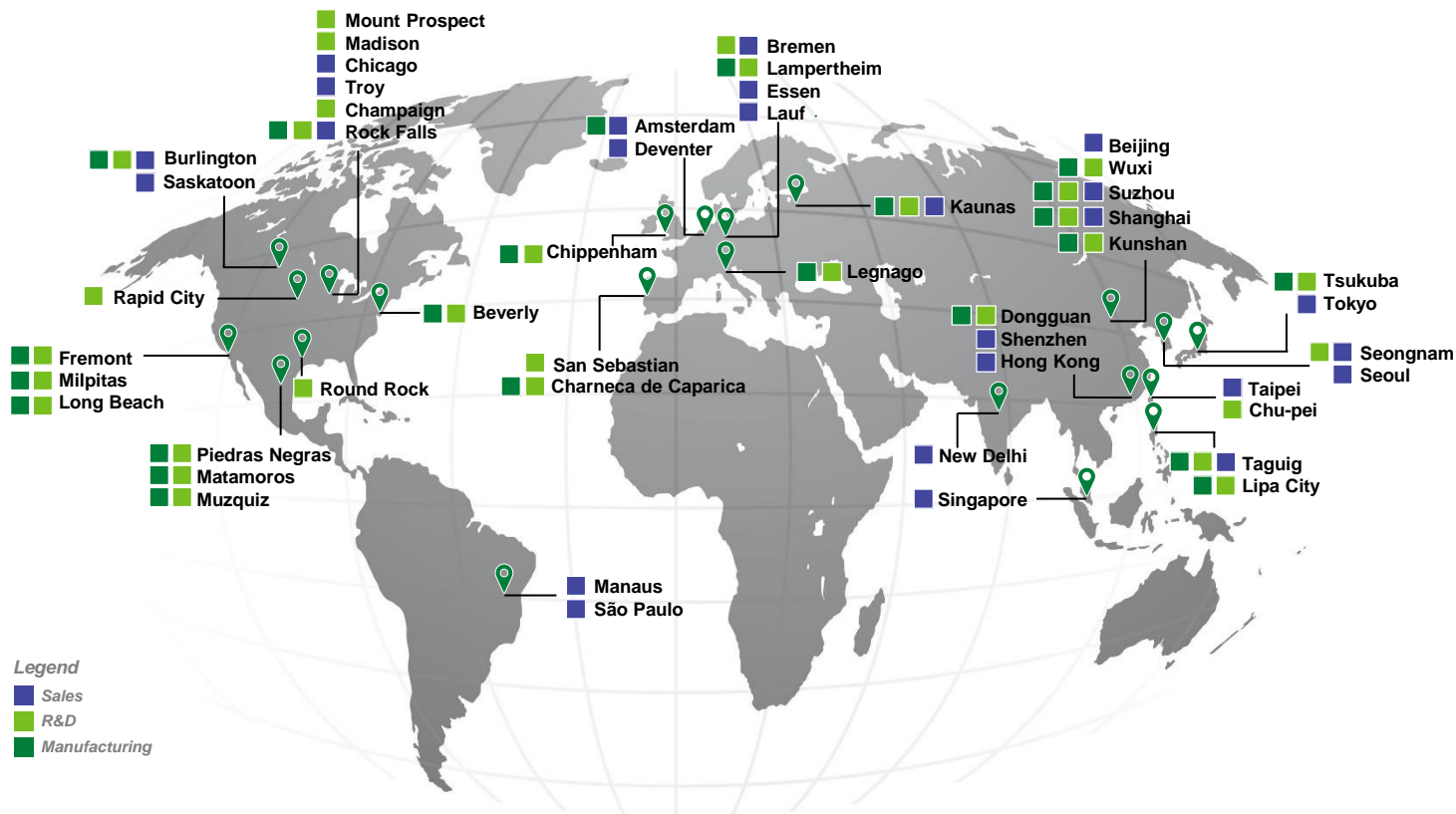
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